

Miniaturized Imaging Spectrometer to Measure Vegetation Structure and Function - MiniSpec

Completed Technology Project (2017 - 2018)



Project Introduction

Earth's vegetated ecosystems are a key factor for sustaining life on Earth. They provide food, fiber and habitat and operate as key components of the carbon, water and energy cycles. They also offer the benefit of functioning to removing CO₂ from the atmosphere and converting it to stored biomass (and oxygen) but are susceptible to changing climate. NASA has strong interest in detecting and predicting changes to Earth's ecosystems as described in their Strategic and Science plans. Vegetation productivity can be estimated by light use efficiency (LUE) models which take into account vegetation stress from lack of soil moisture, disease and insects etc.. Variable shadow fraction, however, limits the accuracy of this approach and currently used methods and concepts require complex sensors with multi-angle views to infer shadow fraction. The instrument concept proposed here is designed to provide the spectral radiance measurements needed for vegetation functioning and high definition vegetation structure diurnal sampling . The scientific measurements needed are visible, near infrared and shortwave infrared calibrated radiances for vegetation function, high definition, ~1 meter resolution panchromatic stereo images for vegetation structure. These measurements are to acquired at three times per day best suited to capture vegetation functional response to environmental conditions. requires a diurnal constellation to capture data at appropriate times during the daylight hours. The most robust and cost effective approach is to deploy six SmallSats on an EELV Secondary Payload (ESPA) ring. This requires that the spectrometer be miniaturized yet fully capable of delivering the spectral and spatial measurements. The proposal team will utilize free form optics enabling high spectral and spatial resolution on a very small bus. For the first time the complete picture of vegetation functioning will be acquired and type, amount and productivity of vegetation will be quantified. (a) Objectives and Benefits The goal of this work is to develop a viable instrument concept using innovative free-form optics suitable for diurnal (i.e., day time multi-temporal) observations of vegetation type, structure and productivity to be deployed on a small satellite constellation. Objectives are: 1) develop and test an instrument concept that uses free form optics and other technologies to reduce size and mass of a hyperspectral spectrometer to acquire reflected solar radiation in the visible to shortwave region of the EM spectrum. 2) include in the instrument concept an optical system enhanced by advanced image processing that can acquire high resolution vegetation structure. 3) include in the instrument concept the requirement to produce instruments for diurnal sampling of spatial and spectral measurements using a modular instrument design and constellation of small satellites. (4) through this proposed project advance the TRL level of the present instrument concept from 2 to 4. (c) The period of performance will be January 1 2017 to June 30 2018, 18 months (d) The entry and planned exit Technology Readiness Level (TRL) are TRL2 to TRL4. The benefits of this proposed instrument is the first higher resolution diurnal measurements of vegetation functioning and tractable approach for reducing errors induced by scene shadows. The data can be used to assess vegetation type, health,



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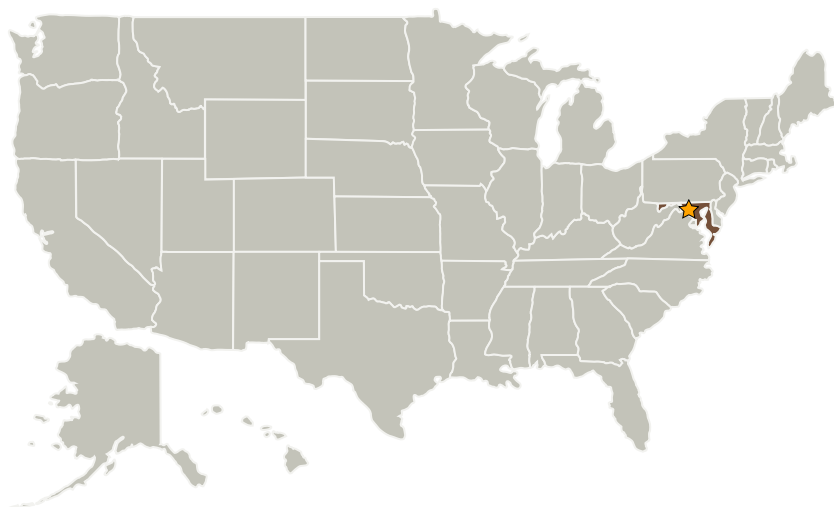
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carbon content in a variety of ecosystems. It is especially powerful in forested areas where varying shadow fraction limits the accuracy of current approaches. The results can be used to monitor vegetation productivity seasonally and eventually long term to identify areas of anomalous productivity or impacts from climate change. The results can also be used to assist the use of global missions currently estimating spectral variables that can be related ecosystem productivity such as Photo Chemical Index (PRI), Solar Induced fluorescence etc.)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Goddard Space Flight Center (GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations

Maryland

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Instrument Incubator

Project Management

Program Director:

Pamela S Millar

Program Manager:

Parminder S Ghuman

Principal Investigator:

Jon Ranson

Co-Investigators:

Melissa L Edgerton
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Patrick L Thompson
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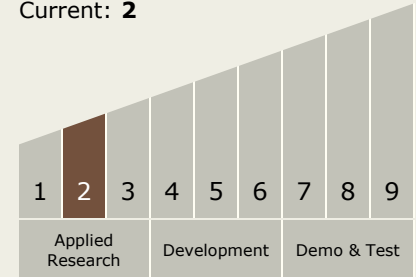
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Technology Maturity (TRL)

Start: 2
Current: 2



Technology Areas

Primary:

- TX08 Sensors and Instruments
 - └ TX08.1 Remote Sensing Instruments/Sensors
 - └ TX08.1.1 Detectors and Focal Planes

Target Destination

Earth